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ABSTRACT

A study investigating the discrepancy between potential and actual use of computer software in elementary education is described. Fifth- and sixth-grade students participating in a computer literacy program in one school were surveyed by questionnaire and interview about the feedback provided in a specific piece of cartooning and creative writing software. Results indicate that the students react to stimuli in ways adults do not, thinking along channels that adults have found non-productive and discontinued using. Therefore, although teachers may try to empathize with students, this can only be achieved through close observation and interviews. Specific recommendations for curriculum designers, administrators, and teachers include the following: (1) incorporation of specific objectives into each lesson; (2) inclusion in the software of function keys allowing students to ask routine vocabulary and concept review questions; (3) selection of programs that are meaningful to students; (4) use of sound, animation, and response mechanisms to stimulate and sustain attention; (5) easy editing as a feature of language arts writing programs; (6) study of additional software; and (7) study of students perceptions of feedback in other schools around the country. A brief bibliography is included. (MSE)

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Microcomputer Feedback to the Student/Learner

Patricia A. Mulligan and Gary G. Bitter

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MICROCOMPUTER FEEDBACK TO THE STUDENT/LEARNER

Patricia A. Mulligan and Gary G. Bitter

Little research to date has reported student assessment of the relevance or usefulness of software used in instructional programs. In the present study students were interviewed about the feedback provided by such programs. It was found that students react to stimuli in ways adults do not. Students think along channels that adults have learned are non-productive, and can therefore no longer remember and activate. Therefore, although the educator might make a special effort to put himself/ herself in the student's place to see problems in the way that the student sees them, this kind of intellectual empathy can really be achieved only indirectly through observation and interviews. When the student's point of view is incorporated into the curriculum, then a program that is in harmony with the student's limitations and growth potential can be assimilated Students are capable of identifying characteristics of software and their recommend-ations should be valued as equal to those made by adults. Students should use and evaluate software with an adult observer.

INTRODUCTION

One aspect of microcomputers is their ability to interact with humans. This feature enables the student to respond to questions, and the computer provides "feedback," so that an interaction, a kind of conversation, is established between person and machine. Microcomputer feedback is defined as any message or display that the microcomputer presents after the student inputs information. Steinberg (1984) defines feedback; it may be as simple as yes or no; or as elaborate as an explanation of why the student's answer is incorrect with directions for how to get the correct answer. Feedback may also be animated graphics or a statement of the student's score.

As in any learning process, learning through the microcomputer provides immediate response, and in this case, that feedback reflects or assesses student responses and encourages student performance in a systematic and consistent way.

Ideally, any computer curriculum is developed by teams of users, with multiple perspectives: the classroom managers, the microcomputer operators, and the learners who will implement the curriculum. It is true that microcomputers have been used in classrooms and laboratories in a variety of ways, and that they have been used as programming tools, for word-processing,

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and as individualized tutors for software for two general types of lesson design: drill and practice exercises and simulation exercises. However, it is unfortunate that curriculum designers, educational specialists, school administrators, classroom teachers, and students have not collaborated in developing effective programs (Komoski, 1984). More disconcerting is the observation that students, the major consumers of educational software, have played only a minor role in the development process. Students have had little input; teachers have contributed what they conjecture is the student perspective because they have informally observed students. More succinctly, little research to date has reported student assessment of the relevance or usefulness of the programs used in instruction.

The purpose of this study is threefold:

1) to formulate propositions and to form a grounded theory base for understanding student/learner computer inter-action,
2) to extract from that theory, the relevant features of educational curriculum,
3) to incorporate these principles into the development of educational curriculum and software.

As part of the study, student interaction with selected microcomputer software was observed, described, analyzed, and interpreted. Students were observed and interviewed in the process of using software programs. Students were asked to discuss the feedback provided by the programs. Students were asked to express their likes and dislikes, to give recommendations for software improvement, and to explore potential uses in their school curricula with the interviewer.

To gather data for a theoretical base, the researchers pursued answers to the following questions:

What characteristics of feedback in software are important to students/learners?

Do media characteristics such as color, sound, animation, and the ability to generate both text and graphics increase appeal to students?

Do learner-related characteristics such as the type of required cognitive processing, the degree of help (mediation), motivating factors, and reduced anxiety producers (affective qualities) change learners' attitudes?

Are user friendly characteristics such as clarity of screen display, positiveness, variety, interactivity, and humor important to learners?

What recommendations can be made to curriculum

designers, educational specialists, school administrators,and classroom teachers for putting the findings into practice?

NEED FOR THE STUDY

Educators hear about the amazing potential of computers and how their use can enhance learning by individualizing instruction. Software program descriptions convince educators that computerized learning is an efficient means for transferring knowledge, but students frequently find programmed learning boring; many software programs are merely academic exercises that lack the motivational force of good classroom instruction. Lack of space, lack of memory, and lack of hardware capability surely do account for part of the problem; but, much of the weakness of software resides in the limitations of the basic instructional design (Cohen, 1985).

One reason for the discrepancy between potential and actual use of educational software has been in the way feedback has been utilized. Feedback is a powerful yet little understood feature in instructional design. Decisions on the use of feedback are presently being based on a small amount of applied research that has been done in this area. Little information from learning theory research has been translated into instructional design.

Instructional designers were swayed by the behaviorist research of the 1960's; and the software programs reflect that learning theory which encouraged immediate feedback following a correct stimulus-response bond. Stimulus-response models resulted in sterile drill and practice excercises. Supporters of the theory applied it to classroom learners by designing learning programs such as programmed instruction and teaching machines. These programs reinforced the student for every correct response, using immediate feedback to shape and maintain behavior as illustrated in Figure 1.

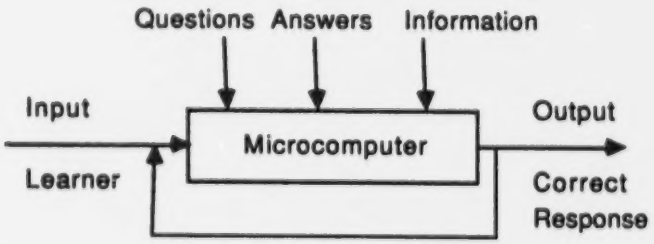

Figure 1 Feedback to learner

This reasoning was a natural outgrowth of behaviorism; however, there has been little classroom evidence that feed-

back following positive responses acts in a reinforcing manner(Cohen,1985; Bardwell,1981; Barringer and Gholson, 1979; Hartley and Lowell,1978; Anderson, Kulhavy, and Andre, 1972).

In contrast to the strong behaviorist tradition a second school of thought developed, forwarding the idea that the main function of feedback is neither to strengthen nor to reinforce correct responses,but to locate errors and provide information so that the learner can correct them (Cohen, 1985; Bardwell, 1981; Barringer and Gholson, 1979; Anderson, Kulhavy, and Andre, 1972).

Whereas the behaviorist model resulted in a right or wrong checking system, informational feedback acts primarily to correct errors, and the number of errors subsequently corrected is directly related to the amount of information offered. Providing only positive feedback during instruction is less effective than giving negative feedback. In addition, by merely indicating "correct" or "wrong," the message is not providing the student with enough informational content to be instructionally effective. The "correct" message alone has been shown to have no significant influence on learning. Thus, there are two separate effects feedback will have on each response students make: 1) to let the students know when they are right or wrong, which can be accomplished with a simple "right" or "wrong" feedback message; and 2) to correct students when they are wrong by providing informational content to help facilitate understanding and comprehension of the material (Cohen, 1985).

The value of both functions in instructional design is obvious. The first function, described as knowledge of results, engages students in corrective activity when they have made an error. It allows them to judge the accuracy of their responses in comprehending and mastering the material. The second function, informational feedback, identifies errors and allows a learner to correct them by providing enough information to help the students locate the error in the response and construct an alternative response. Informational feedback has been acknowledged in research to be one of the most important aspects of feedback (Cohen,1985).

Although researchers have identified what feedback is, they have not developed guidelines on how to use feedback in instructional design and/or curriculum development. There are few practical suggestions in the literature on how to use feedback as an instructional tool. In addition, the directions that are part of the software itself on the use of feedback strategies are often simplistic and thus make feedback ineffective (Cohen, 1985).

If feedback is an important constituent of any learning process, as is evident from the previous discussion, feedback must play a crucial role in the implementation of

instructional design using software programs. Incorrect or inadequate feedback can subvert a well-planned curriculum. In order to study learner feedback appropriately, the investigators selected a grounded theory approach.

METHODS

Grounded theory, which provides a means for investi-gating previously unresearched areas, was the method used in this study. Grounded theory, a form of field methodology, aims to generate theory constructs which explain the action in the social context under study. That is to say, it con-sists of a series of propositions linked together in such a way so as to explain the phenomenon. It is a combination of inductive and deductive approaches; the investigator focuses the research according to a conscious selective process. The way the researcher collects and codesthe data, integrates the categories, generates memos, and constructs theory are all part of the processes of generating theory and research. These are guided and integrated by the emerging theory. The outcomes of the research, therefore, evolve continually; this evolving outcome leads to Glasser and Strauss's view of theory development as a "process" and an "ever-developing entity," not as a perfected product (Glasser and Strauss, 1967).

Procedures

Triangulation, the use of multiple data structures, permits values and perceptions to emerge and forms a basis for the interpretation of results and the confirmation of theory.

Continuous comparative analysis, the process of checking by alternating between phases of inductive and deductive inferencing, involves constant comparison of data with other data, creating propositions about patterns that emerge from the data, testing and evaluating those propositions against further observations, and generating a synthesis from that process. This kind of analysis can be seen from Figure 2.

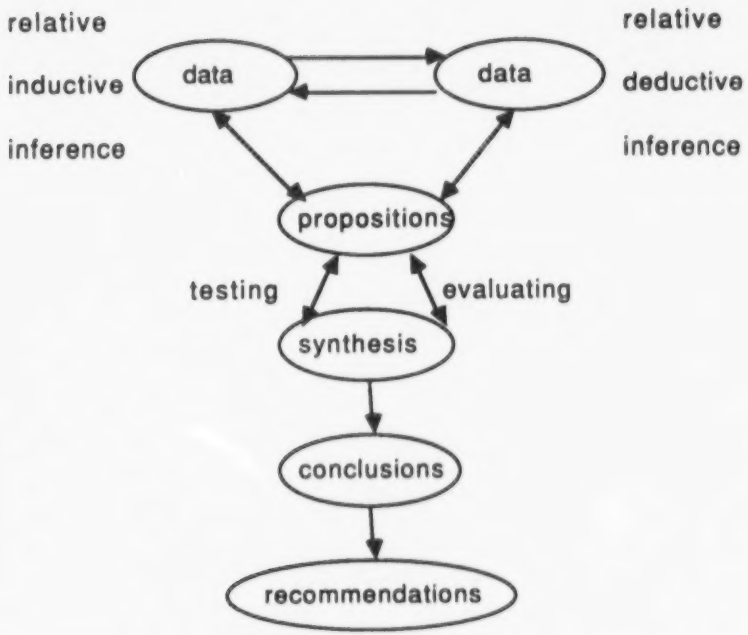

Figure 2 Continuous comparative analysis

Because the process is ongoing, the continuous comparative analysis must be pursued consciously throughout the study. This method is well suited for this particular study because it examines concerns and issues as they emerge from the investigation. At the conclusion of the study the researcher is then able to make recommendations. The following sections describe the language arts studies.

Data Collection

Data collection involved observing, taping interviews, and distributing questionnaires at a northwest Phoenix elementary school which has a Commodore 64 microcomputer laboratory. Two teachers volunteered to participate in this study, one teaches sixth grade and the other runs the microcomputer laboratory. It was decided after consultation with them that there would be two data collections and that the first data collection would begin with the fifth and sixth grade after-school computer program. The teachers have been teaching the students Logo and some word processing with Bank Street Writer. The researcher, who participated in the regular classroom activities for a two-month period, observed the students daily while they were working on their

Logo projects and Create With Garfield, the language arts software selected for this study.

The Create with Garfield software used in this study was provided to the school by the software company, Developmental Learning Materials. The program features are described by the publisher in the following way:

Create with Garfield offers you

- your favorite Garfield characters, plus colorful backgrounds and props for creating your own cartoons
- easy-to-use word processing capabilities for writing your own captions--or use Garfield's own comic quotes
- the ability to use your own backgrounds and props for an unlimited variety of cartoon settings
- an electronic comic feature, which displays your cartoons continuously frame after frame
- the opportunity to print your creations as cartoons, posters, or labels and use them to personalize letterheads, books, name tags, announcements--anything you like!

The objectives are

- to stimulate writing and artistic skills
- to encourage humor for creative thinking
- to give practice writing dialogue
- to help develop a sense of design, balance, sequencing, and spatial relationships.

Both teachers introduced the program to their students. They let the students explore its capabilities for a week. They then brought in cartoons from the newspaper and discussed putting cartoon strips together. The teachers asked each student to develop a plan on paper and show the plan to them before continuing with the project.

The students then worked on their own cartoon strips for the next two weeks. The teachers allowed them to interact and comment on one another's work.

At the end of the unit the researcher tape recorded interviews with the students, asking them to give their impressions of the software.

The second data set collected was with the sixth-grade teacher's regular class. They used Create with Garfield the last three weeks of school. At the end of the three weeks they

were asked to evaluate the program by filling in a written questionnaire.

DATA ANALYSIS

The following coding scheme categories emerged as the data were analyzed:

Cognitive aspects (appealing to the intellectual side, learning, making, doing, and previous computer experience)

Instructional mode (teaches content and students can show its use to others)

Interaction (can do things on the computer that cannot be done with paper and pencil)

Degree of help (student needed help from the teacher or researcher)

Machine capabilities (using the Commodore 64, judgments of slow/fast, or whether it works/does not work)

Graphics (pictures, in Create With Garfield are described as background, stick-ons, and props)

Sound (music and beeps)

Color (authentic or phony)

Variety (more than one activity)

Clarity (clear directions)

Positiveness (pleasant computer responses, fun)

Humor (funny, enjoyable)

Analysis of the classroom observations, oral interviews, and responses to questionnaries becomes difficult as it is necessary to separate any one category from the others because they overlap into one another. Therefore, the categories will not be described separately in sections, but will be integrated into one succinct report.

Students identified aspects of using a computer (aspects of computer literacy, computer experience, or computer skills) which they felt they were taught and learned by using Create With Garfield:

- how to make a cartoon using backgrounds, props, and captions

- how to use windows
- how to use menus
- how to initialize and use a data disk
- how to use new vocabulary
- how to read and follow directions
- how to save and retrieve (load) a cartoon
- how to edit
- how to make people laugh

The students liked the graphics which were described as backgrounds, props, and stick-ons. There is a choice of seven different backgrounds: plain white, room, table, line, tree, fence, and label outline. The stick-ons are Garfield, Odie, Jon, Friends, Props, Quotes, and Write Captions. When friends are selected there is a choice of Arlene, Nermal, and Pooky. The Props contain pictures such as lasagna, refrigerator, TV, etc., and cartoon words such as "CRASH", "BARK", "WHAM". Examples of quotes that can be used are: "NAP ATTACK!," "IT'S HARD TO BE HUMBLE WHEN YOU'RE AS GREAT AS I AM", "WHY ME?" "Write Captions" allows you to write your own statements in stick-on caption bubbles.

The students liked the variety. Many of the students would like to use the Koala pad to generate their own backgrounds and props. One student said that she would "like to change the characters and props so that they could be different sizes." In addition, the students liked creating cartoons that they couldnot draw by themselves with paper and pencil.

There was a great deal more computer experience required of the students in using computer software than was indicated by the identified objectives. Sample lesson plans adding the following objectives to the previously mentioned ones might have helped the teachers plan more effectively:

- To learn the "new" computer vocabulary, a computer terms dictionary would be helpful to teachers and students alike.
- To learn how to use menus and "toggle" back and forth between them; overhead transparencies allowing the teachers to present the concepts would have been helpful.
- To understand the purpose of a data disk and how to intialize one, the teachers needed to have a blank disk for each student.

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Both of the teachers participating in this study have had computer education courses and have taught computer applications for six years. Because of their experience and knowledge of a variety of software programs, they were able to teach the students as problems arose.

> Brian: "Whenever I started the little white screen, I didn't know what to do with that...And then I had to ask Mr. Charles what to do and he told me how to get a background and all the stickers to put on."

Student criticisms may have been expressed as "the directions were not clear," but usually it was the case that they had simply not read the directions.

> April: "I thought it was hard because when I was making a cartoon, I would forget to press something that makes them stay on the screen."
>
> Interviewer: "So you lost them?"
>
> April: "Yeah. I didn't read the directions."

The "Create Menu" was the hardest menu for them to master because from it they would go to other menus and sometimes find themselves in the wrong place and would forget which keys to press to get back to this menu.

CREATE MENU

SEE PICTURE	SPECIAL ARTWORK
GET BACKGROUND	DATA DISK
GET STICK-ONS	CARTOON PRINTER
ERASE STICK-ONS	SEE INSTRUCTIONS

Editing or erasing stick-ons presented problems. The option is available so that one can eliminate characters, props, and captions after they have been placed on the background. The procedure is to select an outline large enough to enclose the entire stick-on. The problem that arises is that any portion of any stick-on that extends into the outline will be erased too. So if two pictures overlap and you erase one, part of the other will be erased as well. The students found it easier to start all over than to use this editing feature.

The students ran into difficulties learning the operations with this menu and requested teacher assistance to walk them through the steps until they learned them. For example, they would see a data disk menu that looks like this:

DATA DISK

SEE INSTRUCTIONS

SEE THE CURRENT CARTOON

LOAD A CARTOON

SAVE THE CURRENT CARTOON

DELETE A CARTOON

INITIALIZE A DATA DISK

CREATE MENU

Students confused not only the words "intializing, loading, and saving," but also the operations that went along with them. If the teachers had better understood the level of computer expertise that would be required of the students the teachers would surely have spent more time talking about and teaching the students about these operations in their lessons. (Such information might have been included in the documentation.)

The color graphics capabilities of the Commodore 64 pleased both teachers and students. Rhoda said, "The colors are nice and look real." She explained when discussing the background with the fence, "It looks like a real fence."

The only problem brought up by the students was color bleeding. Two students were disturbed when they put two graphics side-by-side or overlapped them and the colors bled.

> Chris explained, "You set it next to something, it will mess it up. Like if you have a little dish of dogfood and put a bone on top of it, the bone will cover up part of the bowl with the color."

Overall, the students liked the use of color and hoped some day to print their cartoons in color using a color printer.

The music that introduces Garfield is best described by Mike, one of the teachers.

> There were kids who were barely able to sit in their chairs. The sound was so exciting. We told them where the volume knobs were so that they could adjust them [so that the sound wasn't blaring]. They wanted to be sure they heard the music. I remember the first couple of times we were trying to talk [give directions] to them and load at

> the same time. And the minute you hit that music, you just saw, "All right! This thing sings!" It was great!

The extended-day students didnot comment on the speed of the Commodore 64 disk drive, but three students from the regular sixth grade class did.

> Melanie: "I didn't like how it took so long for some things to load. Sometimes I didn't even finish my picture because it took so long to load."

The microcomputer laboratory printer could not print out the students' cartoons. A printer that was compatible with the software was borrowed, but the printing took a long time. The teachers found that they could not use the software for the writing workshop they had planned because the editing process was so slow. Instead, they ended the cartoon unit after each student had completed one cartoon strip.

When the students were asked what their impressions were of Create with Garfield, their responses were quite positive:

> Manuel and Nathan said that,"the character Garfield is "funny and neat" and that "it is fun to make cartoons."
>
> Frankie expressed that "the other kids in his regular sixth-grade class should have the opportunity to use the program."
>
> Missy thought that "it is better than any other program I've ever used."
>
> April said, "It is just like a Garfield cartoon, and it is fun making a cartoon on the computer."

Data Interpretation

In their evaluations, the students reported aspects of both the hardware and software that relate to the feedback characteristics of the software and to the purpose of this study. The results from the data analysis have been compared to identify as many characteristics of feedback as possible, and they have been integrated into the discussion as highlighted propositions.

Students know the cartoon character Garfield and enjoy interacting with him. The students' familiarity with Garfield's behavior (for example, they all know that he eats great quantities, consumes all with great relish, and relates with other characters in a rather sarcastic mode) eliminates the need for the students to create patterns of behavior for the character, thus following current rhetorical teaching recommendations. In other words, students are not required to supply, from their own creative banks, more than they are

willing to borrow from already established sets. Because the characters are established, the students do not need to create more than the action, the dialogue, and the excitement. They can concentrate on the most exciting part of the creating process: this already complete picture needs only the elements of language and expression that the students want to give the characters, thus eliminating all the anxiety-producing elements of invention.

The work with Garfield amused the children at the same time that it motivated them. The humor involved in the process of composition blurred the fact that the students were learning as they were composing: that is, prewriting, visualizing, reconsidering, planning, revising, checking, and testing. Therefore, they were involved in the project at two levels. Consciously they were occupied with surface issues, while subconscious by they were learning to manipulate language, reinforce computer operating skills, communicating, and composing. In this way the students were freed to be creative, encouraged to explore their artistic abilities and to exploit the potential of the program, and encouraged to find new limits.

The experience of using the Create with Garfield program demanded the use of more computer know-how than most of the students possessed. Thus, the lessons indirectly involved acquisition of skills in the use of both the hardware and the software. Furthermore, the students learned valuable academic skills such as setting objectives, working within a timeframe, refining results, and following directions (If they did not read the directions, they did not succeed.) In addition, the students' reactions and evaluations pointed out the need for several kinds of software improvement.

The language propositions evolved into the grounded theory that follows.

GROUNDED THEORY

Students in elementary and secondary schools react to stimuli in ways adults no longer do. Because they think along channels that adults have learned are non-productive, have weeded out, and can therefore no longer remember and activate, students make errors that adults (teacher, curriculum specialists, administrators, and software specialists) can no longer predict naturally. Therefore, although the educator might make a special effort to put himself/herself in the student's place so as to see phenomena and problems in the way that the student sees them, this kind of intellectual empathy can really be achieved only indirectly through observation, interviews, and questionnaires. When the student's mindset is incorporated into the curriculum, then a program that is in harmony with the student's limitations and growth potential can be developed.

Students are capable of identifying characteristics of feedback which will aid in software adoption review. For this reason, students should be considered for membership into their school district's software review boards. However, taking into account the fact that students lack mature adult ability to objectify, the students should be required to use and evaluate the software with an adult observer. In other words, their recommendations should be evaluated along with those made by the adults.

RECOMMENDATIONS

The following recommendations are made to curriculum designers, educational specialists, school administrators, and classroom teachers:

- For purposes of lesson clarity and orientation, specific objectives for each lesson should be incorporated into each lesson introduction. Research results emphasize such objectives to orient students and reinforce stimuli. (Cohen, 1985; Hartley and Davies,1976; Duchastil and Merrill,1973).

- Function keys which allow the student to ask routine vocabulary and concept review questions should be included in software programs.

- Special care needs to be taken in software selection to include programs that will be meaningful to the children. It is recommended that students be included in the planning phases so that what they like and choose for themselves is included in the curriculum. There are many things we as adults donnot think of as fun any more that children really enjoy and need to have as part of their growing up experience.

- Sound, animation, and response mechanisms stimulate and sustain attention. They should be incorporated into lessons to make them more compelling.

- Language arts writing software, which must be adaptable to the workshop approach, needs to include an easy editing feature. If text editing can be done easily, then the writing and revision process is the students' focus and not the hardware or software functions.

- This study employed the use of two different software programs. It is recommended that other software programs in different content areas with different grade levels of students be studied.

- It is also recommended that a national survey and interview be conducted of schools which include student feedback in their program and curriculum design process.

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